A Tribute to the Iconoclastic Mathematician Dr Francisco Bulnes

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PREFACE

This work is a biography of Dr Francisco Bulnes, a world-renowned academician and famous mathematician, especially in Eastern Europe, the Middle East and Asia. This book is written by some alumni and colleagues of Dr Bulnes, who analyse some of his works and contributions. His case is interesting to analyse because he is a very special mathematician, one of the few universal mathematicians, and by universal, we mean that he knows all areas of mathematics (he has an encyclopaedic knowledge of mathematics). Not only that, he has made important contributions to nanotechnology, electronic and electrical engineering, medicine and education. He is like one of those thinkers and scientists dedicated to science and the study of many areas of nature, such as Newton, who was also interested in mathematics, physics and the philosophy of thought and theology.

Francisco Bulnes has stood out as a Mexican scientist, despite the many problems hindering the real and profound recognition of science in Mexican society, more occupied by money, the news of the Jet-Set and world politics than science issues.

The book discusses and explains, first, his work in the fields of mathematics and physics; second, some important facts about his life and their implications for the world; third, his academic friendship with the United Kingdom and what this means; fourth, it contains an analysis of his theorems and natural laws, fifth, the academic awards he has received, and finally, his contributions to education. The book presents his philosophy within mathematics and outside of it, which we analyse and reflect on because we firmly believe that many of his contributions will be much more highly valued and essential twenty or fifty years from now. The world has to evolve and understand much of the academic work of an iconoclastic mathematician like Dr Francisco Bulnes.

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CHAPTER 1

INTRODUCTION TO DR FRANCISCO BULNES'S THOUGHTS

1.1. The first publications of advanced works, original ideas, perspectives and activities of the seminar "Theory of Representations of Real Reductive Lie Groups"

Francisco Bulnes, from a very young age, began to show independence in his thinking, his behaviour, his search for knowledge, and his preferences in terms of culture, friendships and study, where in particular, he had a taste for mathematics, which showed him a true and deep knowledge of all things and the entire universe. The choice of mathematics for his career and lifelong pursuit was fueled by these thoughts, which further strengthened as his studies progressed to his PhD in mathematics—a culmination of several of his ideas, having studied the infinite Lie theory, functional analysis and questions of homological algebra and dimension theory. Likewise, he chose and developed his doctoral thesis topic guided by his doctorate director, the great Mexican mathematician Dr Félix Recillas-Juárez[1] [1], with whom he also became close friends. His doctoral thesis is entitled *Some Relations between the Cohomological Induction of Vogan-Zuckerman and Langlands Classification*[2], with the AMS subject in topological and Lie groups [2].

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[1] A great educator of mathematicians in Mexico (Javier Gomez-Mont, Alberto Verjovsky, José Seade, Enrique Ramirez de Arellano, among others). He was a faculty of science director of UNAM (the National Autonomous University of Mexico). A great international researcher in France, US, and Germany. Some his friends were for example, Henri Cartan, Claude Chevalley (his PhD director), Witold Hurewicz, Hermann Weyl (who taught Félix Recillas in IAS-Princeton), André Weil, Shiing-Shen Chern, Armand Borel, Lê Dũng Tráng, and many more.

[2] At the Institute of Mathematics UNAM, the PhD thesis can be found under the title in Spanish, "Algunas Relaciones entre la Inducción Cohomológicas de Vogan-Zuckerman y la Clasificación de Langlands."

Figure 1. Compilation of lectures and talks given by Francisco Bulnes in IMUNAM from 2000 until 2005. This book was published by IPN, UNAM, ESIME-IPN, SEP and Yucatán University in 2005 during the Appliedmath event.

During his doctoral studies and as part of the doctorate requirements, Francisco Bulnes gave more than 100 talks and lectures on the topics studied

in his doctorate, which were presented at the university's Institute of Mathematics. Various volumes of compilations of his talks and lectures were published by IM-UNAM, ESFM-IPN, ESIME-IPN, and CINVESTAV, among others [2, 3-7]. See Figures 1 and 2.

Figure 2. Dr Francisco Bulnes is a co-principal adviser with Dr Michael Shapiro. Dr Bulnes has led several international research groups in mathematics and physics [7-9].

Later, Francisco Bulnes researched several problems of mathematical physics, with a special interest in electromagnetic theory and the analysis of signals and systems; this attracted him much more than functional analysis and the applications in Hilbert and Banach spaces, which, however, did give rise to interesting generalisations and inductions around the study of quantum mechanics, dynamical systems, and telecommunications theory, which he tackled with a systematic study in Euclidean spaces of dimension n, of Fourier analysis.

It is worth mentioning that while he was doing his doctorate in mathematics, he made a treatise from his perspective as a mathematician on the analysis of systems and signals, which was published in 1998 by UNAM, with a prologue written by the great Mexican mathematician Dr Félix Recillas Juárez. In this treatise on superior mathematics, Dr Recillas wrote in the prologue,

> Francisco Bulnes makes a clear and calm exposition of Fourier analysis, considering detailed aspects of mathematical analysis and functional analysis, inviting the reader to a very pleasant journey on these topics with applications to telecommunications, control servo systems and theoretical physics: quantum mechanics and relativity [10]

Francisco Bulnes gave a plenary conference at the Technological University of Mexico in 1994 entitled “Controllability and Signaling”, where he presented many of his ideas for the book four years before it was created.

1.2. A Pioneer and Creator of New Theories and Theorems in Mathematical Sciences

Likewise, these preliminary works and others created the scientific and philosophical foundations within mathematics to try and pioneer some new approaches and theories on aspects of studying, from curvature, the most important geometrical invariant of the shape of the spaces and bodies, the Lie groups and their representations, to aspects of study in global analysis, micro-local analysis, deformation theory and derived categories in the study of moduli problems, geometrical ramification problems and geometrical Langland’s problems [11-13].

Teaching mathematics courses for engineering (systems engineering, mechanical engineering and electronic engineering) for several years[3], he identified some parameters and invariant aspects of engineering as the final product of mathematics. He began to build and create his mathematical theory of engineering (or TFI[4], directly from the acronym in Spanish (see acronyms and nomenclatures at the end of the book)), in which he sought to standardise and unify the study of engineering from the most important postulate of his theory, that engineering is the creation of energy technology. Likewise, Francisco Bulnes built his first theorems by trying functional analysis tools and applying Lie groups to define finite actions.

However, in the absence of a uniform methodology and the procedural inconsistencies found in some so-called inductive sciences, which can waste time, the impossibility of a specific application in modern science to the traditional methods (such as Bacon's Method), and the lack of effectiveness and efficiency in those traditional scientific methods, made Francisco Bulnes think of extending the mathematical theory of engineering to a systematic theory of research. This was called the mathematical theory of research and was much more extensive since engineering is a specific area of science [14, 15]. Regarding the concept of curvature, Francisco Bulnes continued to carry out further studies, trying to develop the idea of the universe modelled as a complex Riemannian manifold with singularities, where the treatment of these singularities would be through algebraic-geometric methods considering homogeneous line bundles, with the singularities as zeros on the corresponding polynomials of these line bundles [16, 17]. Likewise, complex projective geometries were generated to model the singularities. Through another function, transform solution classes were obtained, which comprised fields corresponding to those sources or sinks in the universe (singularities of the complex Riemannian manifold that models it). But not only that, Francisco Bulnes considered that he could create a good theory of integrals that could build, through the implicit inverse problems and integral geometry, a theory of the universe based on integral classes giving solutions to universal microscopic and macroscopic phenomena. He wrote a book on the general theory of integral operators for the development of geometry and analysis, contemplating from the orbital integrals on Lie groups, the realisations of many representations of topological groups, including the Feynman integrals to describe the field interaction between particles [18].

[3] Invited to Cuba to for a postdoctoral stay (2006–2007) after a visit as a council academic delegate in the UCI (Informatics Sciences University of Havana, Cuba) to submit a thesis on applied informatics on the theory of algorithms.
[4] Formal Engineering Theory.

Several years later, he took up research on curvature energy and performed several investigations with the help of electronics and created a new unit of measurement (new metrology), the so-called unit of curvature energy, calibrated on an integral operator called a spherizator (whose nucleus is the Gaussian curvature) and a sensor of curvature fed voltage. Curvature energy is a new concept developed by Dr Francisco Bulnes to control, detect, direct and handle field energy [19-24] with the geometrical invariance inherited in the space that models a physical process, considering its spectra useful in sensing signals in physical phenomena.

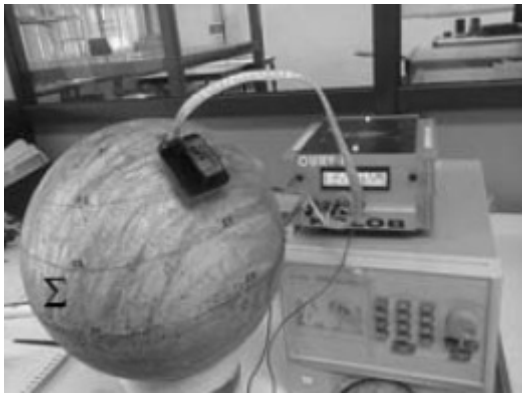

Fig. 3. Gauge sphere used to prove the consistency of the curvature energy unit [23].

Likewise, he created the unit (*Volts/cubic meters*) as a new metrology. This was published in a specialised book on sensors in Europe. It is worth mentioning that Francisco Bulnes has already written and published more than one hundred papers in different international journals on electronics, physics, nanotechnology and mathematics. Also, he has given many international talks at different international events as a speaker, lecturer and plenary lecturer. He has published several book chapters, as well as books and lectures in international research seminars (see Figure 3).

In my particular case, and also of Dr Couper and Dr Michelle Musk, we were interested in the mathematical theory of research because we considered that mathematics is an art form, along with other foundational sciences, as mentioned by Dr Bulnes at different worldwide conferences—in particular the presentation that he gave during one of his many visits to the United Kingdom, where I met him. We began an academic and collaborative friendship.

Applying the mathematical qualities and their essence to research in any area establishes a special paradigm of attention and philosophical innovation of science, where hard-to-explore aspects[5] are due to the impossibility or difficulty of access. Not only that, but the way to obtain substantial advances in studying, being consistent with research, and giving coherence to several ideas as if they were part of a research program, involves much time and effort. Likewise, the most important element of this study is the theory denoted as $Th,$ which must give a foundation to the specific and general investigative tasks and proposes new perspectives and prospects around the object of study.

Thus Dr Bulnes, based on Hilbert's[6] premise that the best application of knowledge is a good theory, extends this premise to the task of research, establishing that "the creation of a good theory is the obtaining of many results, paradigms, applications and conjectures (that is, research for a long time)". Or, as Max Planck[7] would say, the one who makes a lot of effort at the beginning then hardly has to work to obtain new results and paradigms.

Another advantage of the mathematical theory of research with respect to research and technological development is the fact of integrating technological applications as operators t_σ (points of a morphisms group) that are applied on points of a manifold which can be modelled as a Banach or Hilbert manifold to establish a process in technology or technologies. From the point of view of the creation of technologies (this would be the updating of technology), a homomorphism called scientific technologism arises; it is a neologism of the form:

$$\phi(t_\alpha \circ t_\beta) = \phi(t_\alpha) \cdot \phi(t_\beta), \quad (1)$$

where $\circ$, and $\cdot$, are different products in a different space context. One product $\circ$ is for the composition of technologies, and the other, is is for the product of scientific technologisms. One is an operation of the composition of technologies, and the other of the creation process. The law of

[5] Either because the phenomenon is not easy to reproduce, it is in a position that is impossible to access (such as the centre of a reactor), the phenomenon takes place in other dimensions of the universe, or it simply takes place in millionths of a second.
[6] A great mathematician, known as the modern Euclid and the father of functional analysis and integral equations, David Hilbert is considered a giant of the modern mathematics, as big as Gauss or Euler.
[7] Max Karl Ernst Ludwig Planck was a German physicist. He is considered the founder of quantum theory and was awarded the Nobel Prize in Physics in 1918.

composition of the automorphisms α, and $\beta \in G$, takes the form[8] $\xi(\alpha, \beta) = \alpha^{-1}\beta$. Now, the product $\phi(t_\alpha) \cdot \phi(t_\beta)$, is how the product of two energy states makes Dr Bulnes's theory very interesting since producing a new technology should increase the energy level in all its qualities: efficiency, happiness through comfort and ease, execution of the system, and transference ease.

These are all states of energy and are measurable as energy. Therefore, the product of two technology states to produce a third is

$$\phi(t_\alpha \circ t_\beta) = t_\gamma, \quad (2)$$

in the most practical sense, a convolution of technology states. Then scientific technologiscism is, in reality, a neologism of energy, satisfying the principle that engineering is the creation of energy technology. Scientific technologiscism expresses that engineering should be understood as the theory of knowledge for creating technology. Likewise, if Σ, is certain knowledge of a set of true propositions Φ, of a universe of knowledge,

$$\Sigma \subset \Phi, \quad (3)$$

we see that $Th(\Sigma)$ is a theory in engineering if a scientifical technologiscism creates a technology of a certain class. Likewise, let be $\in E = E_{FISMAT}$,[9], $\phi \in \Phi$, and $\sigma \in G$, we have the definition in the engineering context:

$$\phi(\sigma, x) = \phi_\sigma(x) = t_\sigma, \quad (4)$$

Then all technology in any class γ, can be obtained under an engineering homomorphism as:

---

[8] The group G, is a group with structure of Lie group, that is to say, satisfies the group operations of multiplication and inversion, which are smooth mappings (the smoothness of the group multiplication).

$$\xi : G \times G \to G,$$

means that ξ, is a smooth mapping of the product manifold $G \times G$, into G. The two requirements can be combined to the single requirement that the mapping

$$\xi(\alpha, \beta) = \alpha^{-1}\beta,$$

is a smooth mapping of the product manifold into G.

[9] A set or universe of knowledges, mathematics and physics in fact can be considered as our universe, if we consider that this has been designed by an ordered mind.

$$\phi_\sigma(t_\alpha) = \phi_\sigma\big(\phi_\alpha(x)\big) = t_{\alpha^{-1}\sigma(x)} = t_\gamma, \quad (5)$$

Then FET (formal engineering theory) can be constructed, due to Dr Francisco Bulnes. However, Dr Bulnes has gone beyond developing a mathematical engineering theory, considering that applied sciences require engineering to obtain their products. Nevertheless, certain invariants are maintained in the creation of technologies from the applied sciences, and these are the development of a good theory $Th,$ the creation of technology by neologisms $\phi,$ and the transfer of technology as a homotopic process $\tau,$ as defined by Dr Bulnes.

On this last point, technology transfer forces us to question the development of an entity, which can be an individual, a group of individuals, a society, a region, a country, a continent, or even a world in the universe, which can be identified by a knowledge of physics and mathematics.

This is possibly the source of many of the conferences and talks that Dr Francisco Bulnes has given all over the world, where he always questions those attending his talks if mathematics is a creation only of the human intellect or were we designed to understand the beauty of the universe where we live, equipping ourselves with the mathematics to understand it?

This question introduces us to a philosophical problem raised from scholasticism to scientific rationalism and positivism as one of the modern consequences of rationalism.

Dr Bulnes remembers that when he was very young, and especially in the philosophy class taught in high school, the teachers who taught logic and ethics considered him a rationalist due to his inclination towards mathematics. However, Dr Bulnes stated in conversation: "We could be discoverers of the mathematics already inherent in nature, especially in our nature, and we can develop mathematical knowledge by ourselves that helps us develop greater awareness beyond the four-dimensional material universe."

So the higher mind is the garden, and the gardener, too, building our destiny with that higher consciousness acquired through mathematics, metaphysics and quantum physics.

With the development of the formal theory of research and wishing to give consistency to his theory, Dr Bulnes established the so-called consistency theorems, which seek to establish and relate all orders of knowledge (theories, models, technologies, technologisms, prototypes, etc.), including technological products from the central idea of technologism, demonstrating the central problem of the FET. This establishes in depth that models are important for the creation and design of technologies, being, in

all cases, the natural models that already exist in the universe, in nature, and that only human beings try to replicate the level of knowledge we have. For example, the aeroplane has been created and designed to emulate birds, although our knowledge about birds is still limited in terms of the efficiency of their flight system, take-off and landing, and the movement of their wings. However, the model remains there, and further developments should continue to consider it as a model to follow. We have the following scheme defined as the second consistency theorem:

$$\begin{array}{ccc} \Lambda_{SYSTEM}(\Phi_\alpha(E), t_\delta) & & \Phi_\alpha \in Hom(E_{FISMAT}, t_\sigma) \\ & \phi_\beta \nwarrow \quad \swarrow \phi_\delta & \\ \phi_\alpha \downarrow & \Phi_\beta \in Hom(K_\alpha, t_\delta) & \downarrow \phi_\gamma \\ & \nwarrow \phi_\sigma & \end{array}$$

$$Hom(ThMod\,\Phi_\alpha(E_{FISMAT}), C_n\,\Phi_\alpha) \cong \Phi_\zeta \in Hom(\phi_\sigma(t_\gamma), t_\eta), \quad (6)$$

where the last line of the scheme (6) establishes the FET through this isomorphism. Here $Mod,$ is the algebra of models Ψ_j, for some j, $Th,$ the generated theory and C_n, a research unit. Then finally, the research unit of (science and technology) will obtain the technology with a sufficiently solid knowledge base through a set of true propositions and the corresponding models for its design.

Later we will return to this theory of Dr Bulnes. Now let us see his other interesting theories, with their many implications in the deep study of the universe and the projection of future technologies.

Dr Bulnes's energy curvature theory is another way of approaching the field theory problem through its observables and the most important geometric invariant of a space where the field acts. Its energy spectrum is studied, which is constructed through the co-cycles of the cycles of a space manifold and the curvature as a field observable can be detected and measured as an energy signal.

Dr Bulnes uses some integrals developed through his theory to develop integral geometry and obtains new curvature metrology as volts per cubic meter. This was published in a book chapter on sensors [23] and in a research article in the *Journal of Sensor Technology* [21] (see Figure 4).

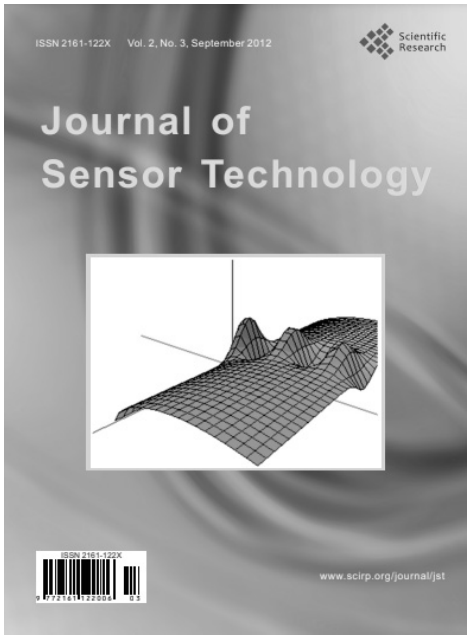

Figure 4. This figure on the front cover is from the article published in the *Journal of Sensor Technology*, 2012, Vol. 2, No. 3, 116–126 by Francisco Bulnes et al.

But not only did Dr Bulnes establish this new concept and theory around it; he also extended it to field torsion, considering torsion as a double curvature. Likewise, he also established that the energy of torsion is its energy of curvature.

Dr Bulnes established different dualities in field theory, geometry and movement to relate the interaction between two fields or movement of bodies in the presence of an electromagnetic field for detecting and measuring torsion. Torsion is a field observable, second curvature in geometry. From the point of view of field theory, torsion is strong evidence of the birth of gravity and its consequences since gravitational waves were detected at astronomical observatories.

Through electronics, he designed an analogue of torsion measurement as evidence of gravitational waves with an experiment to give some insight into what has been studied in the gravitation theories, but with a modern focused study, using invariants as the twistors and spinors for macroscopic and microscopic field theory.

However, the limitations of purely electronic devices only let us see and interpret, using geometrical calculations, certain traces of the electronic signals of torsion, considering a magnetic field is determined in a certain voltage range and a movement of cylindrical trajectory, which, as we know, is constant torsion. However, this verifies conjecture 1.2., and some theorems established in other theoretical and mathematical physics studies. Likewise, a Hall-type sensor detected the magnetic field variation produced from a magnetic dilation [25], which is moved along a cylindrical spiral where the matter agitates the space from which gravity emanates (from the kinematic tensor theory in duality with spinor waves). This also interacts with the magnetic field of the proper dilaton (Figure 5). Francisco Bulnes established and directed this through one of his international research groups.

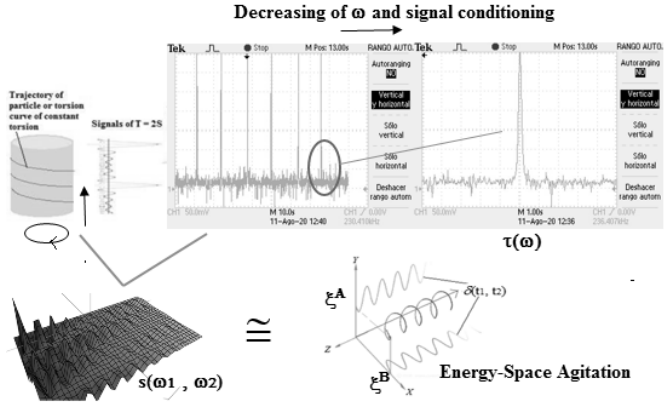

Figure 5. A complete method by the Hall effect sensor for detecting field torsion [26].

The research methods and results are on themes parallel and related to gravity, considering this method is analogous to detecting gravity waves, but in this case, they detect waves of torsion indirectly. If we want to know a complete theory, we have to go back to the theory of curvature on homogeneous spaces that Dr Francisco Bulnes wrote during a semester break while he was the mathematics coordinator of a university. Francisco Bulnes took an agenda given to him and used a draft to write all his theory of curvature on homogeneous spaces as a monograph. Later, a state

university, TESCHA[10] and the SEP would publish a book from all these notes [20]. From this book, many research papers in mathematics, electronics, and theoretical physics were published in various specialised scientific journals.

The deep study of curvature in geometry and the development of research on integral geometry by Dr Bulnes, specifically on homogeneous spaces (classes of spaces), led him to derive important technical theorems and lemmas for geometry and the topology of curvature as a tempered distribution. His contact with electronic engineering in the creation of sensors and energy transducers by curvature lead him to establish more conjectures about the nature of torsion and its vital importance in all the processes of the universe. This can be expressed ordinarily as the appearance of waves in space-time agitations. This energy can be an indium of gravity, which scientists measure as gravitational waves when other aspects are involved in field equations [27, 28].

The torsion field mechanism is fundamental for all evolution processes of sidereal objects such as galaxies, black holes, supernova stars, pulsars and nebula. He also observed that this field effect could have relevance and importance for creating future technologies.

1.3. Creativity surges unstoppable

As we have mentioned, the creativity of Francisco Bulnes has been in many areas where he has applied mathematics in addition to his research in pure mathematics. That creativity led him to receive recognition and honour (see Figure 6), not only in mathematics but also in the philosophy of education, by trying to transform education taught at university into a more comprehensive education, where the creativity and imagination of the student are encouraged. For this, it incorporates some specific topics of mathematical research theory, which we have already mentioned, but the aspect of education models with the implementation of research.

[10] Tecnológico de Estudios Superiores Chalco—College of Technological of Higher Studies Chalco, State of Mexico. Here Dr Francisco Bulnes has been a full professor and researcher in electronics engineering since 2006.

Figure 6. Some examples of badges and honours received by Dr Francisco Bulnes, due to his brilliant trajectory. There are more than 50 badges [29-31].

I (Figure 7) will continue with more information and anecdotes about Dr Francisco Bulnes.

Figure 7. Dr Helen Thrift.

CHAPTER 2

THE SOCIAL AND SCIENTIFIC STRUGGLES OF A UNIVERSAL MATHEMATICIAN

2.1. Constantly living under economic crises in Mexico

Francisco Bulnes went through economically difficult times, derived from the recurring economic crises in the country due to poor government in Mexico (he experienced all the crises since 1976 (devaluation), 1982 (the PEMEX failure), 1987 (devaluation), 1994 (the December error), and 2009 (a world crisis), 2019 (the COVID-19 pandemic); and also perhaps due to mismanagement of his money since he used to buy many books and music records when sometimes, he only had just enough left to survive during early adulthood.

While Francisco Bulnes continued his postgraduate studies, struggling with economic ups and downs and working simultaneously while studying for his master's and doctorate, the CONACYT scholarship at that time could not give him enough to maintain a home, a partner or a child.

Back then, the scholarships were not so good, and they had the condition that the scholarship holder must dedicate themselves 100% to study and not to work anywhere. This works for a single person with no children and no commitment, but Francisco Bulnes did not fall into that class, so he had to pay for himself and support his family, his master's degree and his doctorate. However, he received some support for publications of papers, conferences and talks about his doctorate (see Figure 8). He wrote several memoirs of conferences, by IMUNAM, during the doctoral seminar (see Figure 8) [32, 33]. That was a very productive time despite the economic problems and responsibilities acquired.

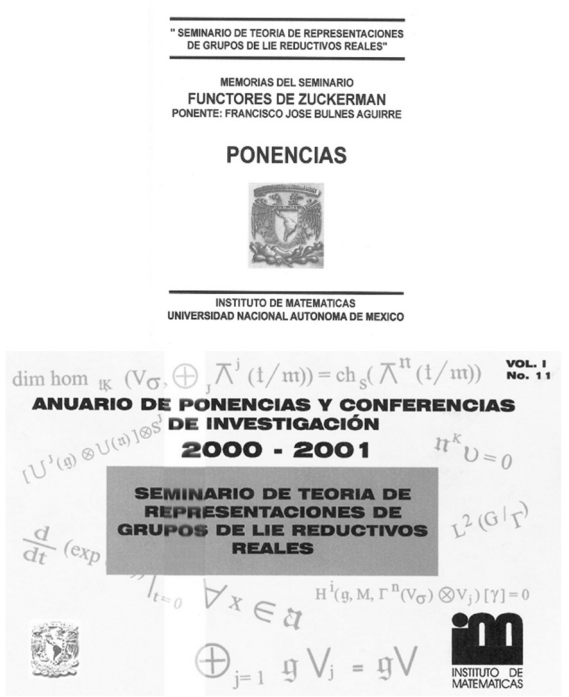

Figure 8. Publications made by the Institute of Mathematics, on presentations and talks given by Francisco Bulnes, as part of the requirements for his doctorate [32, 33].

2.2. The Trips to Tabasco, Campeche, Cotzacoalcos Veracruz, and Tamaulipas

When Francisco Bulnes was Mathematics Coordinator at the Valley of Mexico University (UVM), Lomas Verdes Campus, he travelled the entire east coast of the Mexican Republic, teaching advanced mathematics courses for engineers within the master's program in engineering. systems and computing taught to all staff of PEMEX, AMIME, UTECAM[1], and the Valley of Mexico University (UVM), Villahermosa Campus [34].

[1] PEMEX. Mexican Oils. It is a Mexican para-state, which unfortunately represents 80 percent of the national GDP.
AMIME. Mexican Association of Mechanical and Electrical Engineers.
UTECAM. Technological University of Campeche.

Figure 9. Dr Francisco Bulnes (light blue shirt), with some of his master's students from UTECAM (the Technological University of Campeche). Some were officials of UTECAM and others of PEMEX [34, 35].

He toured the territories of Tabasco from Villahermosa to Centla; he also went to Ciudad del Carmen, Campeche, and made a tour of the Zacatal bridge (see Figures 9 and 10) to go to the mainland and attended the Technological University of Campeche (see Figure 9), where he was teaching advanced mathematics to engineers. Some engineers who went there were directors of the oil wells stationed off the coast of Ciudad del Carmen.

During his trips along the Campeche highway, Francisco Bulnes observed the abundant foliage of the jungle that contrasted with the lagoons in different places. Those places were mystical and helped him reflect more deeply on his country. How could the small towns and villages have so much wealth in natural resources and yet be poverty-stricken?

Figure 10. The Zacatal Bridge joins the island of Ciudad del Carmen, which also belongs to Campeche, with the continental part of the state of Campeche itself. This is one of the longest bridges built over the sea and is 3.861km long.

Figure 11. Ciudad del Carmen is a city inhabited mostly by petroleum, civil, electromechanical and computer systems engineers, qualified technicians and oil extraction workers. In the photograph, we can see an oil extraction platform in shallow water. This is about to leave for the open sea near Ciudad del Carmen or the continental part of Campeche [35].

Abundant wealth should directly benefit those populations, and with much of the oil profit should come checks and balances to ensure a certain amount of benefit for the entire Mexican population. Dr Bulnes dreamt of establishing an imaginary corridor from Ciudad del Carmen, passing along the coast of Campeche, Tabasco, passing through Coatzacoalcos Veracruz, and arriving at the port of Matamoros. Good roads, port infrastructure and important airports would benefit the poorer people, the fishermen, and everyone settled in the towns and villages of Campeche, Tabasco, Veracruz and Tamaulipas. Farmers could plant anything on those lands, rich in minerals, and fishermen could sell their fresh snapper and encourage a regional shrimp industry.

Dr Francisco Bulnes met PEMEX authorities and requested a report on the periods of operation, updating of equipment and maintenance of one of the oil extraction platforms stationed in Ciudad del Carmen. He was disappointed as the platforms had equipment from the 1970s, had several damaged pipes, or had fractures that could unleash a fire at any time, and the hydraulic and pneumatic part of the platforms operated poorly, and the automation of some processes was not even carried out. There was an operator for some processes that could have been fully automated. The software could not quickly calculate the compensation required for the dynamic and hydrostatic pressure of the extraction processes, etc. (see Figure 11).

Dr Bulnes proposed research based on the Fourier analysis for implementing a hypercomplex platform for all the automation processes of extraction platforms and other processes derived from or connected with implementing fast calculations on the dynamic pressures. However, as usually happens in Mexico, the proposal was passed on to the corresponding PEMEX directors, at least those from the Campeche, Tabasco and Veracruz areas, without effect. PEMEX's problem, which is the same as always, is how impeded it is by paying civil servants' salaries, excessively high worker benefits, and corruption in its different union associations. There is no intention to invest in modernising and updating PEMEX's engineering infrastructure.

Dr Bulnes established friendships with many platform engineers, mid-level managers and engineers from AMIME (see Figures 12 and 13) and the universities that provided qualified personnel (engineers) to the PEMEX Company.

Figure 12. Here we see Dr Bulnes (in the navy blue shirt) chatting to several engineers doing their master's degrees in systems engineering and computer science. Dr Bulnes taught them advanced mathematics for engineers, including differential equations, integral transformations, special functions, and, in some cases, numerical analysis topics were included.

On the other hand, all the petroleum engineers stationed in Tabasco were also waiting for Dr Bulnes's modernisation project to become a reality. I established a good relationship with them when Dr Francisco Bulnes went to Tabasco to lecture or present a postgraduate course. Many of the engineers wondered if the project would be able to develop since the intention was to tie the professional and specialisation part together in a master's degree in systems engineering, and along with the development of PEMEX, improve its infrastructure and have software and hardware with efficient and effective calculations far superior to that existing at an international level. But the usual thing happened, politics managed everything—that is the tragi-comedy of Mexico.